DAIMLER

Heavy-Duty Powertrain and Vehicle Development

A Look Toward 2020

Mercedes-Benz FREIGHTLINER FUSO WESTERN STAR Thomas BUILT BUSES BHARATBENZ

U.S. DEPARTMENT OF ENERGY
DEER 2011 DETROIT
DIRECTIONS IN ENGINE-EFFICIENCY AND EMISSIONS RESEARCH CONFERENCE

Detroit, October 4, 2011

Mark Groeneweg

Daimler Trucks - Powertrain Engineering, Nafta

Overview of Daimler Trucks Brands

FREIGHTLINER

Mercedes-Benz

WESTERN STAR

DETROIT DIESEL

Thomas BUILT BUSES

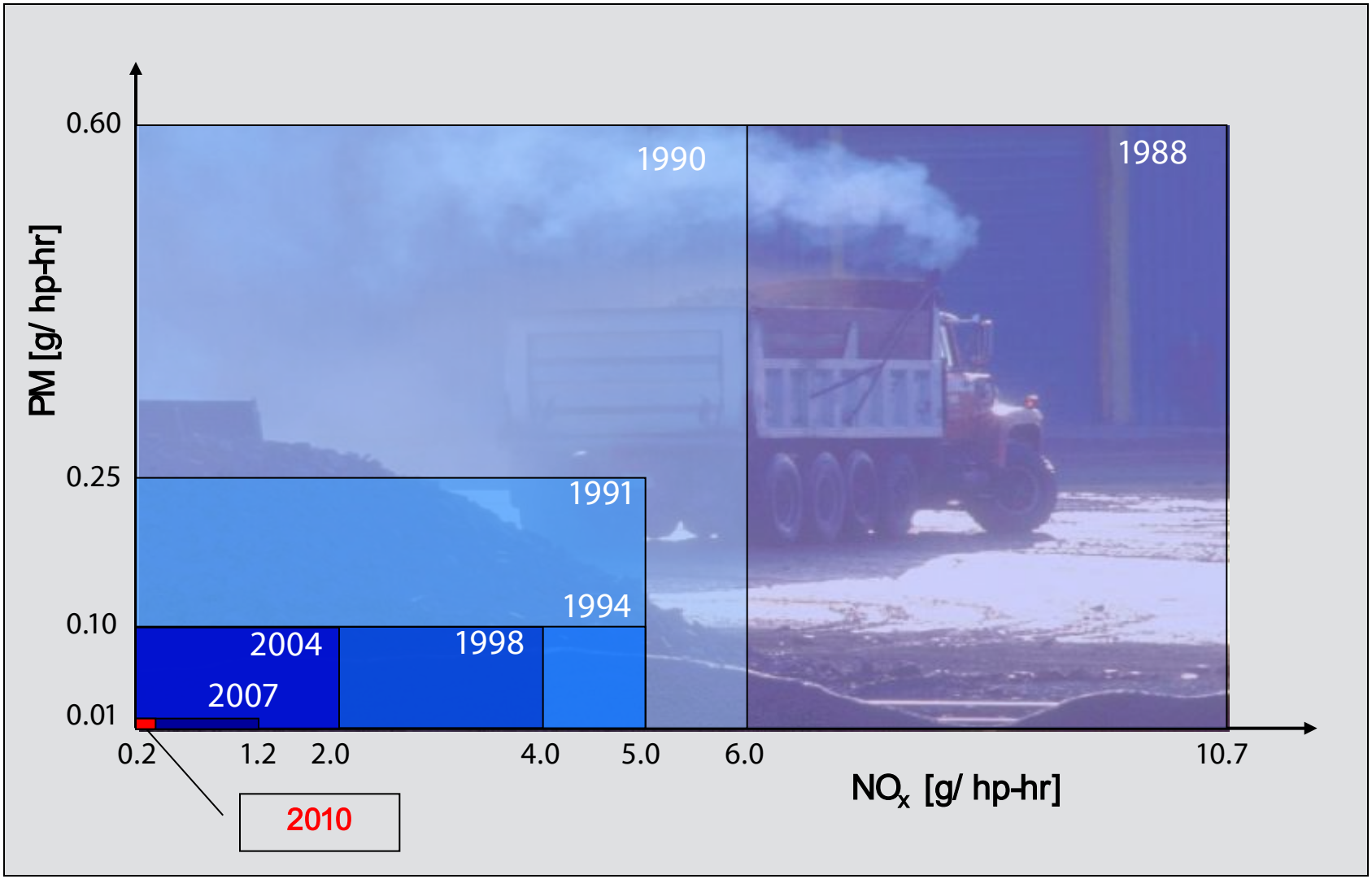
FUSO

DTNA

New Addition to the Family

BHARATBENZ

The Age of Criteria Pollutant Emissions Reduction (past)



What will the future look like?

There is the prediction of possibilities ….

Next winner of the Super Bowl

Winning lottery numbers

Precise timing and extent of market behavior

But …. this is not the way Engineers work…

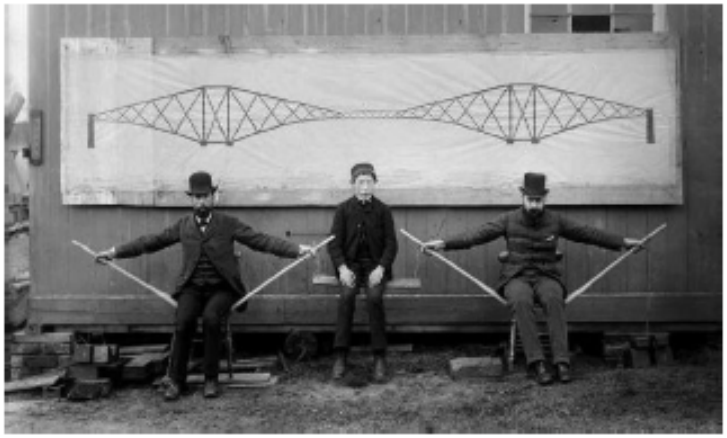
What will the future look like ?

Certainty of recurring change

- Seasons
- Day/Night
- Economy (Up & Down)

Certainty of linear change

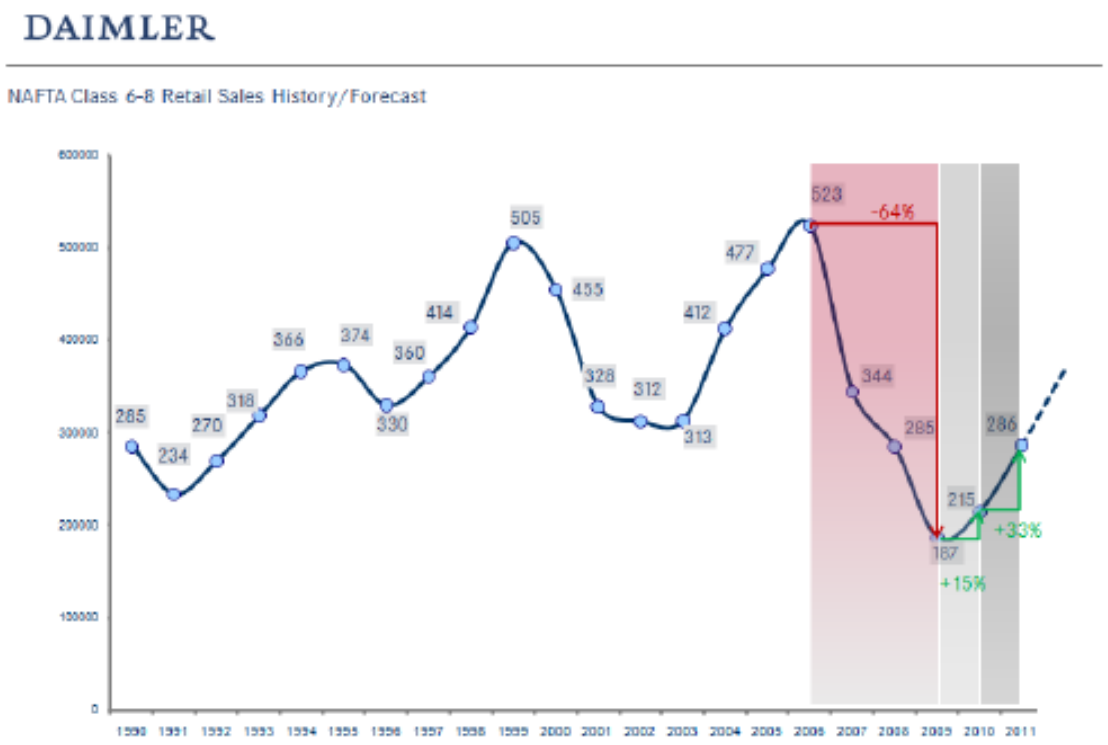
- Fuel prices
- Globalization
- Engineering genius



We can fear or embrace change....
ultimately, the smartest & the fastest will prevail

What do we know for sure?
Certainty of cycles

The economic cycle of our industry



Gearing up

Capacity planning

Product cycles

R&D spending

It went down – it goes up – it will go down again..... eventually

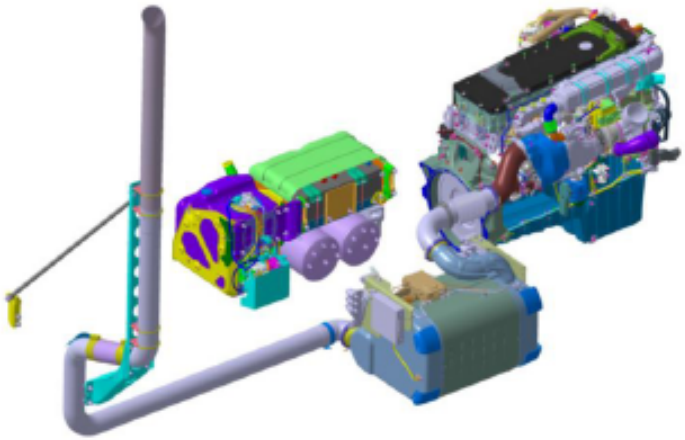
What else do we know for sure? Certainty of "linear" change

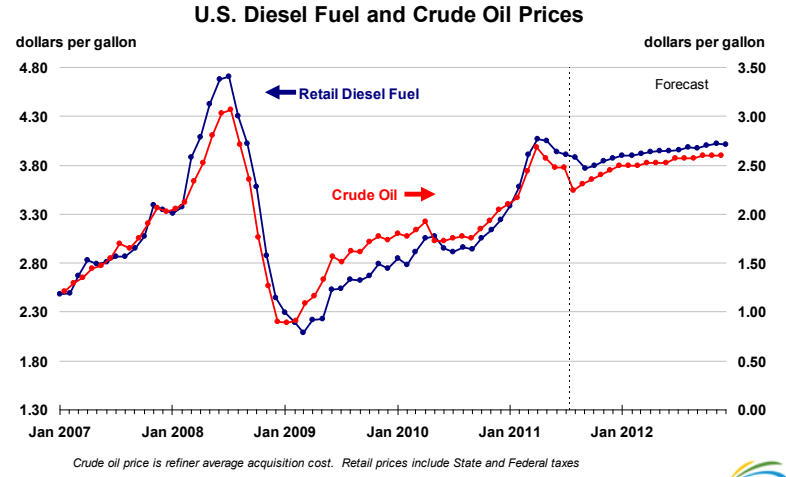
Fuel price increase

Environmental requirements

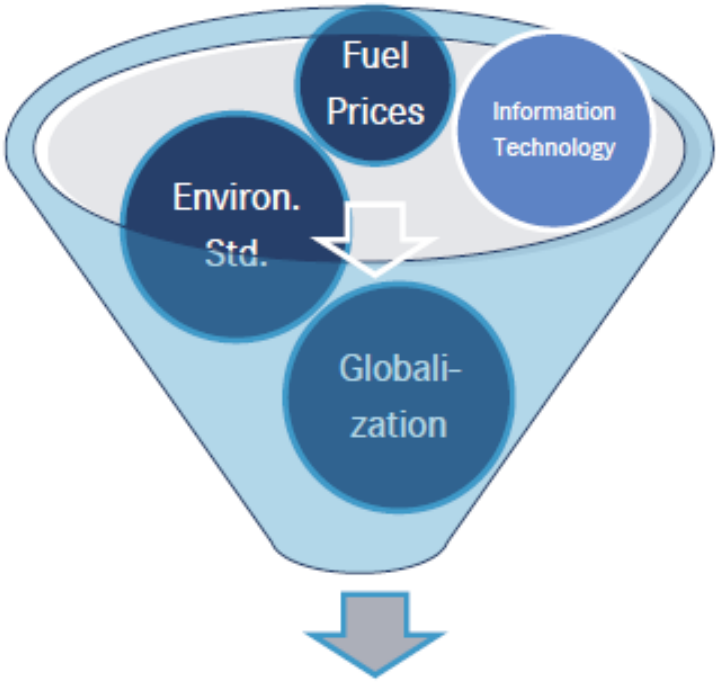
Globalization

Progress in information technology and electronics





What are the consequences for the industry?



More fuel efficient trucks

New markets

Enhanced safety features offering

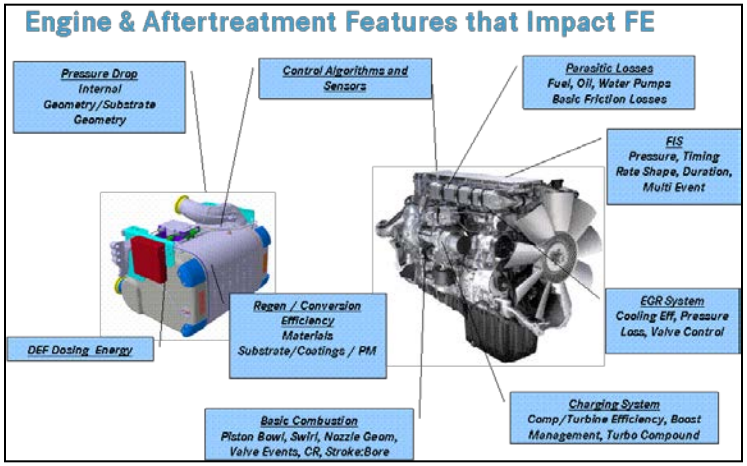
Growth beyond unit sales

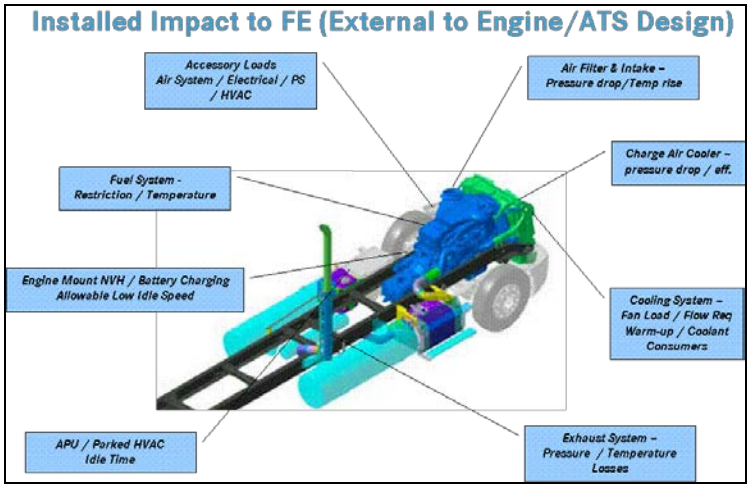
Reduction of chance for human operation error

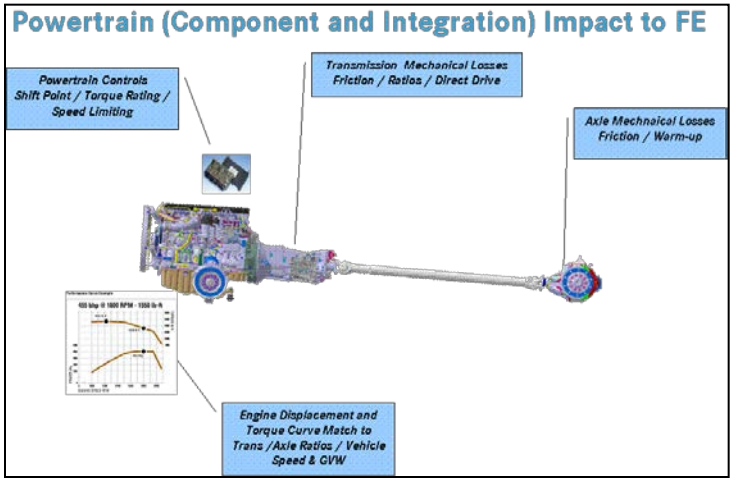
Increased competition and chances for technology development

What are the consequences for the 'engine'?

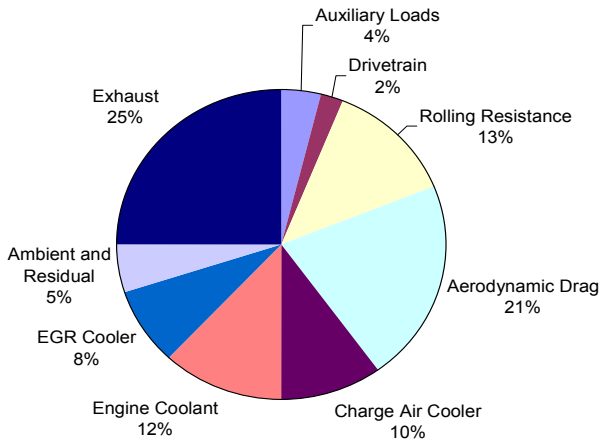
Real World Fuel Efficiency Improvement – Systems Viewpoint





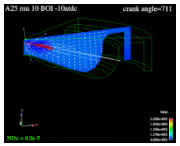


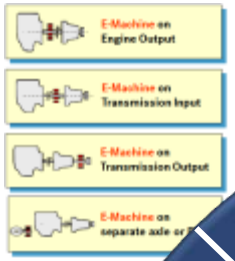
1st law energy balance

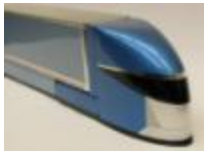


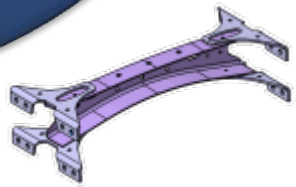
Comprehensive System Development

Example: Super Truck Program









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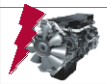
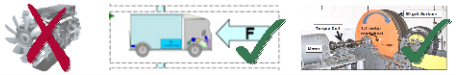
The age of CO_2 begins

USA: GHG/ FE Regulation signed August 2011

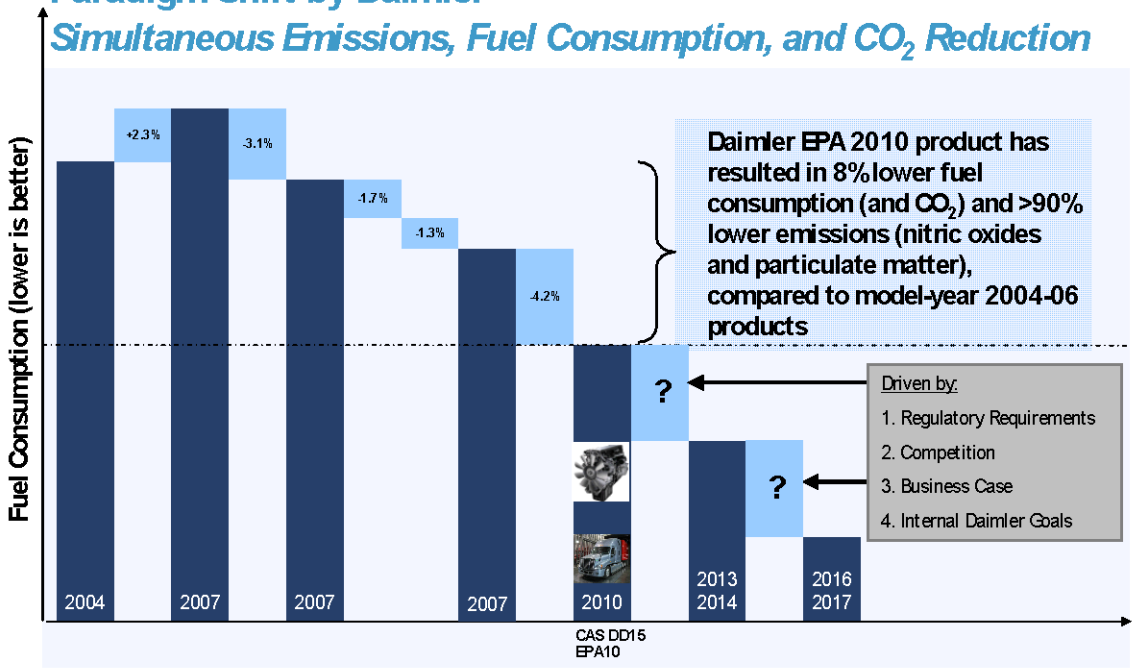
Components	
Measurement Principle	Separate engine (test bench) and vehicle standard (simulation)
Separated engine standard	 Cost effective GHG optimization jeopardized
Simulation Input Data	
Segmentation / Cycles	Weight oriented (GVW) segment approach
Limits / Flexibilities	15 regulatory classes (engines & vehicles). No credit exchange vehicle & engine
Metrics	g/ ton-mile

Comments
• Separate engine and

Real world fuel consumption reductions vs. regulatory annou

Paradigm Shift by Daimler

Simultaneous Emissions, Fuel Consumption, and CO_2 Reduction

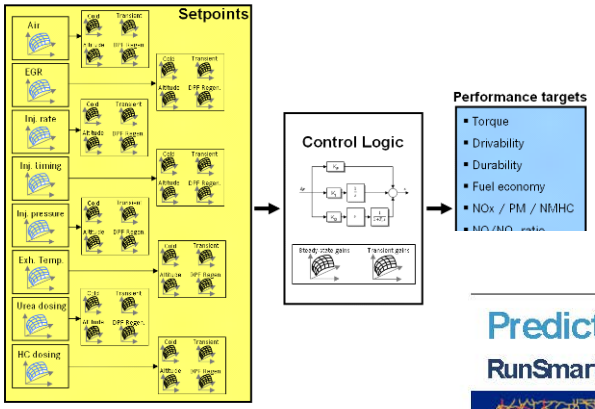


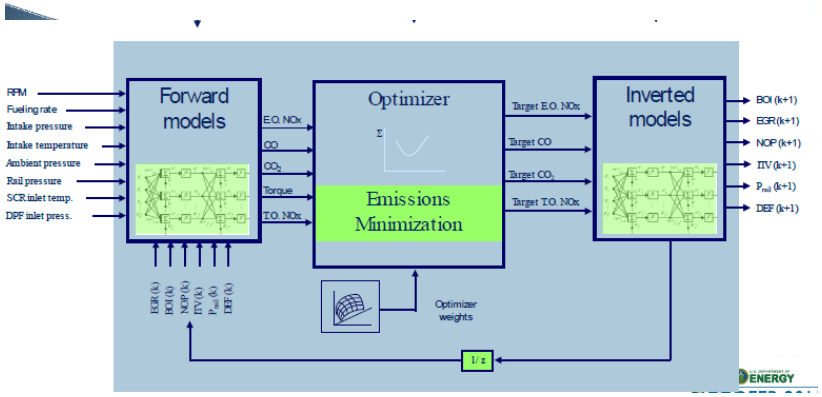
Electronics and controls (r)evolution

Predictive Engine Control With On-Board Fuel Efficiency Optimization

Why Predictive Controls ?

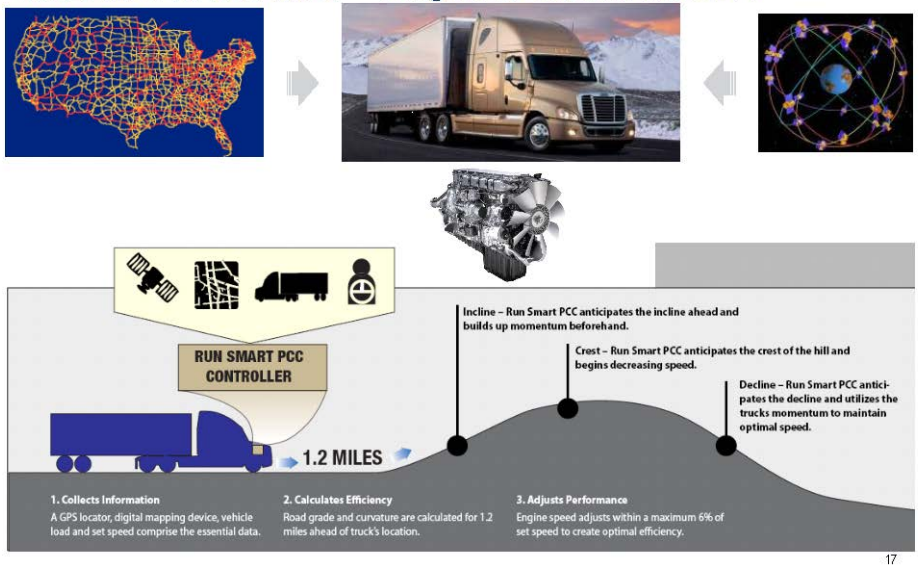
- Factorial increase in calibration space
- Multiple performance targets





Predictive Technology

RunSmart Predictive Cruise™ – Freightliner Cascadia with DD15



17

Competition for talent continues….

Global workforce is a fact…

Innovative workplaces produce innovation…..

Nurturing interest in science and math is required…

In Summary…

- "Linear" change will define certain aspects of the future
- Advances in technology are a certainty – today's trends in technology make the future visible
- Globalization in emissions regulation will be a driving force for real efficiency progress – if done correctly
- Freight efficiency improvements require not only engine advancements but also powertrain improvement, vehicle improvements and optimized system integration
- Exciting times continue for the commercial vehicle industry
- YOU are at the front line of technology development

Our engineers are the 'engine' that will propel us into the future of commercial vehicles